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Growth performance of tellicherry crossbred female kids supplemented with varying levels of hydroponic maize fodder

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Abstract
A study was conducted to assess the growth performance of Tellicherry crossbred female kids fed with varying levels of hydroponic maize fodder. 24 Tellicherry crossbred femalekids aged around 4 months were randomly selected and allotted into three treatment groups namely, control (100% concentrate mixture), treatment 1 (75% concentrate & 25 % hydroponic maize fodder) and treatment 2 (50% concentrate & 50% hydroponic maize fodder) consisting of eight animals each. The study was conducted for a period of8 months.Phase feeding was followed as per NRC. During the study, initial body weight, final body weight, overall weight gain, average daily gain, body condition score, dry matter fed and intake per day and feed conversion efficiency were recorded to assess the growth performance. Economics were calculated for the entire study period.Hydroponic maize fodder supplemented groups had significantly (P<0.05) higher final body weight and total weight gain than the control group. Though the hydroponic fodder supplemented groups had significantly (P<0.01) higher total cost of feeding/animal from 4 months to 1 year of age (Rs.), numerically they had the lowest cost of production/kg live weight gain (Rs.) than the control group. No statistical differencewas noticed between the groups in terms of initial body weight, average daily gain, body condition score, dry matter fed and intake per day, feed conversion efficiency and cost of feeding per animal per day (Rs.). To conclude, the weight gain in the Tellicherry female kids can be enhanced by supplementing hydroponic maize fodder at 25% and 50% level with the added advantage of the reduced cost of production/kg live weight gain.

Keywords: Tellicherry crossbred femalekids, hydroponic maize fodder, growth performance, economics

Introduction
Goats have the widest ecological range playing a significant role in providing supplementary income and livelihood to millions of resource-poor farmers and landless labourers of rural India. Besides meat and milk, goats also produce good quality skin, valuable pashminafibre and manure [1]. India occupies the first position in goat milk production (5.75 million MT), the second position in terms of goat population (135.17 million) and goat meat production (1041.11 thousand tons) in the world [2, 1, 3]. The goat sector contributes 14,453 crores to the agricultural economy of the country through the meat (6,851 crores), milk (4,588 crores), skin (648 crores), etc. which accounts for around 8 per cent of the Gross Domestic Product (GDP) from the livestock sector. Besides, the goat sector generates about 4% rural employment and about 20 million small and marginal farmers' and landless labourers' families depend on goats for their livelihood partially or completely. As per NSSO reports, per capita per month consumption of goat meat/ mutton has increased from 53 gram to 61 gram during 2003-04 to 2009-10. Considering 3% growth in per capita goat meat/mutton consumption, the demand for goat meat by 2050 would be 2.13 million tons [4].
Responding to the market signals, the goat production system in India has been slowly moving from extensive to intensive system of management for commercial production [5]. In last few years, goat production in the country gained momentum in the form of a commercially viable enterprise as evidenced by the increasing interest of young entrepreneurs to develop knowledge and skill in this species [1].
Hydroponic fodder production is one of the recent methods of fodder production for livestock which provides a year-round supply of fresh green fodder while using minimal labour, land, water and space [6, 7, 8]. It is one of the emerging technologies widely adopted in many parts of the world and proved as the most feasible and easily adoptable one for improving the growth

and reproduction in farm animals [9]. Hydroponic fodder is a germinated grain along with the root, which is palatable and consumed along with the shoots without any wasting [10]. It has high feed quality that is rich with proteins, fibres, vitamins, and minerals [11, 12] with health beneficial effects on animals [13].

In India, hitherto limited research has been done on the feeding of hydroponic fodder for small ruminants. Hence, this novel approach has been attempted to study the growth performance of Tellicherry crossbred female kids fed with hydroponic maize fodder.

Materials and Methods

Twenty four Tellicherry crossbred femalekids aged around 4 months were randomly selected and allotted into three treatment groups namely, control (100% concentrate mixture), treatment 1 (75% concentrate & 25% hydroponic maize fodder) and treatment 2 (50% concentrate & 50% hydroponic maize fodder) consisting of eight animals each. All the animals were reared under similar standard management conditions.The study was conducted for a period of 8 months from 4 months to one year of age.

Production of hydroponic maize fodder

Hydroponic maize fodder was produced using the TANUVAS – UIIC - Low cost hydroponic green fodder machine fabricated at University Innovation and Instrumentation Centre (UIIC), TANUVAS. Recently harvested good quality yellow maize seeds with less than 12% moisture were selected. The required quantity of seeds i.e. 6 kg/ machine were soaked in tap water for 20 hours. Water was then drained and the seeds were packed in gunny bags for germination. Water was sprinkled periodically over the gunny bag to maintain moisture. After 24 hours, seeds were taken out from the gunny bags and loaded onto 6 different hydroponic fodder trays at the rate of 1 kg per tray (dry weight). The seed loaded trays were then kept on the lowest row of the hydroponic fodder machine. Water was sprinkled every hour for about 4 minutes. The trays were shifted to immediate upper row daily. After 8 days of the growth period in the machine, the fodders were taken out on the 9th day for feeding to goat kids.

Proximate analysis and palatability study of hydroponic maize fodder (HMF)

Proximate composition of experimental feed and fodders were carried out as per AOAC (2005). Palatability study was carried out for a period of one week. The kids were fed with 200 g HMF/head on day 1 and the quantity was increased by 50 g/day until it reaches 500 g/head/day on day 7.

Formulation of feeding trial

Based on the results of proximate analysis of feed and fodders and palatability study of HMF, the experimental ration was formulated using "Maryland Meat Goat Ration Evaluator" as per "National Research Council's Nutrient Requirements of Small Ruminants" published in 2007. For each bodyweight stages, three treatment rations were formulated as per experimental design as given in Table 1.

Table 1: Quantity of feed and fodders fed to different bodyweight stages and treatment groups

Bodyweight stages (kg)	Control Conventional feeding					Treatment 1 25% HMF + 75% concentrate					Treatment 2 50% HMF + 50% concentrate				
	Concentrate feed	CO5 Grass	Hydroponic maize fodder	COFS 29 dry fodder	Tree fodder	Concentrate feed	CO5 Grass	Hydroponic maize fodder	COFS 29 dry fodder	Tree fodder	Concentrate feed	CO5 Grass	Hydroponic maize fodder	COFS 29 dry fodder	Tree fodder
	(g)					(g)					(g)				
10 – 15	150	300	0	100	200	112.5	3000	227	100	200	75	300	454	100	200
15 – 20	175	500	0	150	200	131.25	500	272	150	200	87.5	500	544	150	200
20 – 25	200	1500	0	200	250	150	1500	286	200	250	100	1500	567	200	250

Recording of data

The bodyweight of all the femalekids was recorded initially and subsequently at fortnight intervals from 4 months to one year of age. The average feed intake (g/day) and average dry matter intake (g/day) was calculated by using the formula given below:

Average feed intake (g/day) = Total quantity fed (kg) – Residual feed (kg)

Average dry matter intake (g/day) = Average feed intake (kg/day) X Dry matter content of the feed)

The overall body weight gain was calculated by subtracting initial body weight from final body weight. The average daily gain during the study period was calculated by subtracting initial body weight from the final body weight of any particular period. The feed conversion efficiency was calculated by using the following formula:

$$\text{Feed conversion efficiency (\%)} = \frac{\text{Weight gain (kg)}}{\text{Dry matter consumed (kg)}} \times 100$$

Body condition scores were recorded at a monthly interval as per the method suggested by [14]with 0.5 increments.Cost of production/kg live weight gain (Rs.) is calculated using the formula:

$$\text{Cost of production/kg live weight gain (Rs.)} = \frac{\text{Cost of feeding during the period (Rs.)}}{\text{Total body weight gain during the period (kg)}}$$

The total cost of feeding/animal from 4 months to 1 year of age and the cost of feeding per animal per day for each treatment group was calculated using the formula given below:

The total cost of feeding/animal from 4 months to 1 year of age = Sum of [cost of each feedstuff/kg X Total quantity of the feedstuff fed from 4 months to 1 year of age]

Cost of feeding per animal per day (Rs.) = Total cost of feeding/animal / Total number of days

Statistical analysis

The collected data from various groups were subjected to statistical analysis by analysis of variance using SPSS software. Treatment differences were considered significant at $P<0.05$. If significance was determined, Duncan was performed wherever applicable to differentiate between treatments.

Results and Discussion

The proximate composition of experimental feed and fodders are given in Table 2.

Table 2: Proximate composition of experimental feed and fodders

Feed/Fodder	Moisture (%)	DM (%)	CP (%)	EE (%)	CF (%)	TA (%)	NFE (%)	TDN (%)
Goat concentrate feed	6.86	93.14	16.28	1.76	11.85	12.12	58.29	73.31
Hydroponic maize fodder	83.42	16.58	12.44	2.65	9.49	2.77	72.65	82.22
CO_5 grass	74.15	25.85	10.42	1.75	36.95	10.85	40.03	68.55
Mixed tree fodder	70.11	29.89	8.5	3.04	13.85	9.24	65.30	75.89
COFS29 dry fodder	10.85	89.15	7.45	1.15	21.22	10.08	60.10	89.92

Palatability study of hydroponic maize fodder

The mean±S.E intake of hydroponic maize fodder/day/kid in Tellicherry crossbred kids during the seven-day palatability study is presented in Table 3.

Table 3: Palatability study of hydroponic maize fodder in Tellicherry crossbred kids The mean±S.E of intake/day/kid (n= 16)

Days	Quantity given/ kid (g)	Left Over/kid (g)	Intake/kid/day (g)
1	200	3.33±0.6	197.00±0.94
2	250	4.50±0.56	244.00±0.58
3	300	3.50±0.42	296.67±0.62
4	350	4.67±0.67	344.67±0.83
5	400	4.50±0.56	396.00±0.94
6	450	2.33±0.5	447.33±0.88
7	500	5.00±0.58	494.67±0.44

From the observations made in the present study, it can be seen that the maximum intake of hydroponic maize fodder was 494.67±0.44 g/kid on the 7th day of the palatability study as seen in Table 3.

The result of the present study was following [15] who reported a maximum intake of hydroponic maize fodder in goat kids to be 0.5 g/animal/day at the end of 7 days palatability study. The palatability of the hydroponic maize fodder may be due to the high leafy and succulent nature of the hydroponic green fodder because of low CF and high NFE content compared to conventional maize fodder [16].

Growth performance

The various production parameters studied are given in Table 4.

Table 4: Growth performance and economics of Tellicherry crossbred femalekids fed varying levels of hydroponic maize fodder

Parameters	Control	Treatment 1 (25% HMF)	Treatment 2 (50% HMF)	'F' value
Initial body weight (kg)	9.74±0.35	10.82±0.65	11.40±0.33	3.22^{NS}
Final body weight (kg)	18.63^{a}±1.16	23.40^{b}±1.37	23.50^{b}±1.67	3.84*
Total weight gain (kg)	8.89^{a}±1.08	12.58^{b}±0.88	12.10^{ab}±1.62	2.63*
Overall ADG (g/day)	32.00±0.01	45.00±0.01	43.00±0.01	1.53^{NS}
Dry matter fed (g/day)	453.11±42.82	505.68±56.39	500.59±56.71	0.30^{NS}
Dry matter intake (g/day)	381.50±17.65	477.00±56.41	470.97±56.73	1.27^{NS}
Feed conversion efficiency (%)	8.49±1.03	9.72±0.68	9.48±1.27	0.40^{NS}
Body condition score	2.71±0.14	2.79±0.17	2.84±0.12	2.52^{NS}
Cost of production/kg live weight gain (Rs.)	156.49±19.68	113.15±7.85	119.65±17.44	2.17^{NS}
Cost of feeding per animal per day (Rs.)	4.70±0.17	5.10±0.45	4.80±0.41	0.30^{NS}
Total cost of feeding / animal from 4 months to 1 year of age (Rs.)	1288.23^{a}±1.86	1389.16^{c}±2.13	1310.20^{b}±2.08	744.54**

NS – Not Significant;

*Significant at five per cent level ($P<0.05$);

** Significant at one per cent level ($P<0.01$); Means bearing different superscript in the same column differ significantly.

Initial and final body weight

No significant difference was noticed in the mean initial body weight of female kids at the start of the study. The initial body weight at the start of the study was 9.74±0.35 kg, 10.82±0.65 kg and 11.40±0.33 kg for the control treatment 1 and 2 groups respectively. The final body weight of femalekids at the end of the study was significantly ($P<0.05$) higher in the hydroponic supplemented groups (T_1 - 23.40±1.37 kg; T_2 - 23.50±1.67 kg) than the control group (18.63±1.16 kg). The final body weight of female kids i.e. at one year of age obtained in the hydroponic supplemented groups (T_1 - 23.40±1.37 kg; T_2 -23.50±1.67 kg) were higher than those

reported by [17] who reported the bodyweight of Tellicherry female kids at one year of age to be 18.07±0.53 kg however control group final body weight was following their findings (18.63±1.16 kg).

Overall body weight gain

Significantly (P<0.05) highest overall weight gain was noticed in femalekids fed with diet containing 25 per cent HMF (12.58±0.88 kg) followed by 50 per cent HMF (12.10±1.62kg) and 0 per cent HMF i.e. control group (8.89±1.08 kg). These findings were in agreement with [9] who reported significantly (P<0.05) higher total body weight gain (kg) in Konkan Kanyal goats fed 60:40 Finger millet straw (FMS) and hydroponic maize fodder (HMF) and 60:20:20 FMS + HMF + hydroponic barley fodder (HBF) and [18] who reported significantly (P<0.05) higher total gain in Awaasi lambs fed hydroponic barley when compared to lambs fed the control diet. Higher body weight gain in lambs/kids supplemented with hydroponic fodder might be due to the ability of the hydroponic fodder to supply most of the necessary nutrients [19].

Average daily gain

Even though there was no statistical difference, numerically higher overall average daily gain was noticed in female kids with the diet containing 25 and 50 per cent HMF (45.00±0.01 g, 43.00±0.01 g) followed by 0 per cent HMF (32.00 ±0.01 g).The overall ADG in femalekids supplemented with hydroponic maize fodder (T_1 - 45.00±0.01 g, T_2 -43.00±0.01 g) observed in the present study were higher than that reported by [17] in Tellicherry female kids (35.87±1.77 g) [9]. also reported significantly (P<0.05) higher daily weight gain (g/day) in Konkan Kanyal goats fed 60:40 Finger millet straw (FMS) and hydroponic maize fodder (HMF) and 60:20:20 FMS + HMF + hydroponic barley fodder (HBF).[18]who studied the effect of hydroponic barley fodder on Awassi lambs performance also reported higher (P<0.05) average daily gain in lambs fed HB diet (266 g/gained/day) than lambs fed the control diet (191 g/gained/day). The results were statistically in agreement with [20] who found no adverse effects on ADG in Tellicherry goat kids fed hydroponic horse gram or sun hemp fodder replacing 50% of the concentrate mixture.

The better weight gain might be due to feeding of hydroponics fodder which increased the digestibility of the nutrients attributed to the tenderness of the fodder [21]. The highly soluble protein and amino acids in response to the early plant growth and enzymatic transformations of sprouted grains are responsible for improved digestibility in animals [12, 10]. also reported that the digestibility of the nutrients of the hydroponics fodder was comparable with the highly digestible legumes like berseem and clovers [22]. Stated that the sprouting of grain causes increased enzyme activity, a loss of total DM, an increase in total protein, a change in amino acid composition, a decrease in starch, increases in sugars, a slight increase in crude fat and crude fibre, and slightly higher amounts of certain vitamins and minerals. Altogether these positive nutritional changes cause an improvement of digestion and absorption by using less energy, enabling the animal to save lots of and use energy for other important activities like weight gain [23].

Dry matter intake

The statistical analysis revealed no significant difference between the treatment groups in terms of dry matter fed and dry matter intake. The results of the present study were in accordance with [24] who reported no effect of feeding hydroponic barley on the feed intake (FI) in lactating Awassi ewes and [20] who reported no significant difference in total feed intake/head/30 day on DM basis between the control and hydroponic horse gram fodder or hydroponic sun hemp fodder supplemented groups [25]. also reported that feeding of HMF by replacing the maize grain of the concentrate mixture had not altered the DM intake (11.20 vs. 11.52 kg/day) in lactating cows.

Feed conversion efficiency

The feed conversion efficiency calculated for Tellicherry crossbred female kids was 8.49±1.03, 9.72±0.68 and 9.48±1.27 per cent respectively for the diets containing 0, 25 and 50 per cent hydroponic maize fodder respectively. The statistical analysis revealed no difference in feed conversion efficiency among the treatment groups. The results of the present study were in accordance with [15] who found no adverse effects on feed conversion ratio (FCR) in Tellicherry goat kids fed hydroponic horse gram or sun hemp fodder replacing concentrate mixture at 50% level.

Body condition score

Body condition score (BCS) is the best simple indicator of available fat reserves which can be used by the animal in periods of high energy demand [14]. The observations made in the present study revealed no significant difference in body condition score between the treatment groups [14]. Stated that healthy goat has BCS of 2.5 to 4.0 in most cases. The results of the present study were in accordance with their statement.

Economics

Though the total cost of feeding/animal from 4 months to 1 year of age (Rs.) was statistically higher in hydroponic fodder fed group than the control group, numerically lowest cost of production/kg live weight gain (Rs.) was noticed in T_1 (Rs.113.15±7.85) followed by T_2 (Rs.119.65±17.44). The results were in agreement with [26] who reported that in terms of economic efficiency, it is more profitable and economically efficient in terms of feed cost per weight gain to feed pigs on 50% concentrate and 50% hydroponics maize fodder (Con50HM50) as compared to 100% concentrate (Con100) and 100% hydroponics maize fodder (HM100) [9]. who studied the nutritional benefit and economic value of feeding hydroponically grown maize and barley fodder in Konkan Kanyal goats also concluded that feeding of finger millet straw + hydroponic maize and barley fodder at a proportion of 60:40 for growing goats (T3, T5 and T4) was highly beneficial and economically valid [24]. Who investigated the biological and economical values of hydroponic barley (HB) in lactating Awassi ewes also concluded that cost of feed can be reduced by 42% by using hydroponic barley as feed for lactating sheep.

Conclusion

Hydroponic maize fodder may be included in the diet of fed Tellicherry crossbred female kids replacing concentrate at 25% and 50% level for enhanced weight gain with the added advantage of the reduced cost of production/kg live weight gain.

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